Decision Rationale

Total Maximum Daily Loads for
The Primary Contact Use (Bacteriological) Impairment on Beaver Creek

I. Introduction

The Clean Water Act (CWA) requires a Total Maximum Daily Load (TMDL) be developed for those water bodies identified as impaired by a state where technology-based and other controls will not provide for attainment of water quality standards. A TMDL is a determination of the amount of a pollutant from point, nonpoint, and natural background sources, including a margin of safety (MOS), that may be discharged to a water quality-limited water body.

This document will set forth the Environmental Protection Agency's (EPA) rationale for approving the TMDL for the primary contact use (bacteriological) impairment on Beaver Creek. EPA's rationale is based on the determination that the TMDL meets the following eight regulatory conditions pursuant to 40 CFR §130.

1) The TMDL is designed to implement applicable water quality standards.
2) The TMDL includes a total allowable load as well as individual waste load allocations (WLAs) and load allocations (LAs).
3) The TMDL considers the impacts of background pollutant contributions.
4) The TMDL considers critical environmental conditions.
5) The TMDL considers seasonal environmental variations.
6) The TMDL includes a MOS.
7) There is reasonable assurance that the TMDL can be met.
8) The TMDL has been subject to public participation.

II. Background

The Beaver Creek Watershed is located in Rockingham County, Virginia. Beaver Creek is a tributary to the North River which flows into the Shenandoah River. The impaired segment of Beaver Creek begins at its headwaters and terminates 5.57 miles downstream at its confluence with the Briery Branch. The 10,000-acre watershed is rural with forested and agricultural land making up 60 and 39 percent of the watershed area respectively. The remainder of the watershed (1 percent) is composed of residential land. There are seven small point sources in the watershed.

In response to Section 303(d) of the CWA, the Virginia Department of Environmental Quality (VADEQ) listed 5.57 miles of Beaver Creek (VAV-B18R) on Virginia's 2002 Section 303(d) list as being unable to attain its primary contact use. This decision was based on observed violations of the Commonwealth's bacteriological criteria. At the time of its listing, the bacteria criteria used fecal coliform as an indicator species and had an instantaneous standard

1,000 colony forming units (cfu) per 100 milliliters (ml) and geometric mean standard of 200 cfu/100ml. Beaver Creek was also listed for an aquatic life use impairment in 2002 but further analysis revealed that this impairment no longer exists. This decision rationale will address the TMDL for the impairment of the primary contact use.

Fecal coliform is a bacterium which can be found within the intestinal tract of all warm blooded animals. Therefore, fecal coliform can be found in the fecal wastes of all warm blooded animals. Fecal coliform in itself is not a pathogenic organism. However, fecal coliform indicates the presence of fecal wastes and the potential for the existence of other pathogenic bacteria. The higher concentrations of fecal coliform indicate the elevated likelihood of increased pathogenic organisms.

EPA encouraged the states to use e-coli and enterococci as the indicator species instead of fecal coliform. A better correlation was drawn between the concentrations of e-coli and enterococci, and the incidence of gastrointestinal illness. The Commonwealth adopted e-coli and enterococci criteria in January 2003. According to the new criteria, streams will be evaluated via the e-coli and enterococci criteria after 12 samples have been collected using these indicator species. The fecal coliform criteria will be used in the interim. Twelve e-coli samples were collected from Beaver Creek, and it is therefore, assessed according to the new criteria.

As Virginia designates all of its waters for primary contact, all waters were required to meet the bacteriological standard for primary contact. Virginia's standard applies for all flows, there are no high or low flow exemptions. The fecal coliform criteria was modified in 2003 to require that the fecal coliform concentration not exceed a geometric mean of 200 cfu per 100 ml of water for two or more samples collected over a month, nor shall more than 10 percent of the total samples exceed 400 cfu/100 ml of water. The new criteria also established concentration based requirements for e-coli. The e-coli criteria requires a geometric mean concentration of 126 cfu/100 ml of water with no sample exceeding 235 cfu/100 ml of water. Unlike the fecal coliform criteria, which allows a 10 percent violation rate, the new e-coli criteria requires the concentration of e-coli not exceed 235 cfu/100 ml of water. The fecal coliform criteria no longer apply to this water. Unlike the fecal coliform criteria, the e-coli concentrations are capped and no sample can exceed 235 cfu/100 ml of water.

Although the TMDL and criteria require the 235 cfu/100 ml of water concentration limit not be exceeded, waters are not placed on the Section 303(d) list if their violation rate does not exceed 10 percent. Therefore, Beaver Creek may be deemed as attaining its primary contact use prior to the implementation of all of the TMDL reductions. It is necessary to keep this in mind because of the reductions required to attain the instantaneous criteria for e-coli in the model.

The TMDL submitted by Virginia is designed to determine the acceptable load of e-coli which can be delivered to the impaired waters, as demonstrated by the Hydrologic Simulation

Program Fortran (HSPF)[1], in order to ensure that the water quality standard is attained and maintained. HSPF was considered an appropriate model to analyze the impaired water because of its dynamic ability to simulate both watershed loading and receiving water quality over a wide range of conditions. The model was run to determine the fecal coliform loading to Beaver Creek as most of the loading information and sampling results are based on fecal coliform. The in-stream fecal coliform concentrations were then converted to e-coli using a conversion factor established by the Commonwealth.

The TMDL analysis allocates the application/deposition of fecal coliform to land based and instream sources. For land based sources, the HSPF model accounts for the buildup and washoff of pollutants from these areas. Buildup (accumulation) refers to the complex spectrum of dry-weather processes that deposit or remove (die-off) pollutants between storms.[2] Washoff is the removal of fecal coliform which occurs as a result of runoff associated with storm events. These two processes allow the HSPF model to determine the amount of fecal coliform from land based sources which is reaching the stream. Point sources and wastes deposited directly to the stream were treated as direct deposits. Wastes which are deposited directly to the stream do not need a transport mechanism. During extremely low flows, the direct deposit of fecal coliform from cattle and wildlife was reduced. This was conducted in the modeling process because it was unlikely that cattle or wildlife would be wading in Beaver Creek when its depth was below 0.67 (cattle) or 0.54 (wildlife) inches and the impacts associated with the waste of one animal at these low flows skews the model.

Local rainfall and temperature data were needed to develop the model. Weather data provides the rainfall data which drives the TMDL model. Weather data was collected from several weather stations including Dale Enterprise, Lynchburg Airport and Elkins Airport. Dale Enterprise was the primary station, but its data set needed to be expanded in order obtain specific meteorological information. This information was obtained from the two airport weather stations.

A hydrologic calibration was not conducted on Beaver Creek due to the lack of a complete flow record. Parameters for the hydrologic model were determined based on the

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[1]Bicknell, B.R., J.C. Imhoff, J.L. Little, and R.C. Johanson. 1993. Hydrologic Simulation Program-FORTRAN (HSPF): User's Manual for release 10.0. EPA 600/3-84-066. U.S. Environmental Protection Agency, Environmental Research Laboratory, Athens, GA.

[2]CH2MHILL, 2000. Fecal Coliform TMDL Development for Cedar, Hall, Byers, and Hutton Creeks Virginia,

characteristics of Beaver Creek and the model for Muddy Creek (a nearby watershed with an EPA approved TMDL). Although a full calibration was not conducted, VADEQ collected flow data from four watershed locations five times in the winter of 2004-2005. The simulated flow data was compared to observed flow data collected throughout the watershed.

The TMDL was modeled using fecal coliform loading rates as was done in previous TMDL efforts. The fecal coliform concentrations were then converted to e-coli concentrations using a translator equation developed by VADEQ. Significant reductions in the modeled load were required in order for Beaver Creek to attain the e-coli criteria in the model. More stringent reductions were required to meet the instantaneous standard than the geometric mean.

Table 1 - Summarizes the Specific Elements of the TMDL.

Segment	Parameter	TMDL (cfu/yr)	WLA (cfu/yr)	LA (cfu/yr)	MOS
Beaver Creek	E-coli	1.5E+13	1.22E+10	1.5E+13	Implicit

The United States Fish and Wildlife Service has been provided with copy of this TMDL.

III. Discussion of Regulatory Conditions

EPA finds that Virginia has provided sufficient information to meet all of the eight basic requirements for establishing a primary contact (bacteriological) impairment TMDL for Beaver Creek. EPA is therefore approving this TMDL. EPA's approval is outlined according to the regulatory requirements listed below.

1) The TMDL is designed to meet the applicable water quality standards.

Virginia has indicated that excessive levels of fecal coliform due to nonpoint sources (both wet weather and directly deposited nonpoint sources) have caused violations of the water quality criteria and designated uses on Beaver Creek. The water quality criterion for fecal coliform was a geometric mean 200 cfu/100 ml or an instantaneous standard of no more than 1,000 cfu/100 ml. Two or more samples over a 30-day period are required for the geometric mean standard. Since the state rarely collects more than one sample over a 30-day period, most of the samples were measured against the instantaneous standard. Approximately 30 percent of the samples collected from Beaver Creek from September 1994 through June 2003 violated the fecal coliform criteria. The violation rate increased to 50 percent when compared against the new fecal coliform criteria.

The Commonwealth has changed its bacteriological criteria as indicated above. The new criteria require that the fecal coliform concentration not exceed a geometric mean of 200 cfu per 100 ml of water for two or more samples collected over a month nor shall more than 10 percent

of the total samples exceed 400 cfu/100 ml of water. The new e-coli criteria requires a

geometric mean of 126 cfu/100ml of water with no sample exceeding 235 cfu/100 ml of water.

The HSPF model was used to determine the fecal coliform deposition rates to the land as well as loadings to the stream from direct deposit sources. Once the existing load was determined, allocations were assigned to each source category to develop a loading pattern that would allow Beaver Creek to support the e-coli water quality criterion and primary contact use. The following discussion is intended to describe how controls on the loading of e-coli to Beaver Creek will ensure that the criterion is attained.

The TMDL modelers determined the fecal coliform production rates within the watershed. Data used in the model was obtained from a wide array of sources, including farm practices in the area, the amount and concentration of farm animals, animal access to the stream, wildlife in the watershed, wildlife fecal production rates, landuses, weather, stream geometry, etc.. The model combined all of the data to determine the hydrology and water quality of the stream.

The lands within the watersheds were categorized into specific landuses. The landuses had specific loading rates and characteristics that were defined by the modelers. Therefore, the loading rates are different in lands defined as forested versus pasture. Pasture lands support cattle and are influenced differently by stormwater runoff.

The Beaver Creek TMDL model was run using weather data collected from several area weather stations. This data was used to determine the precipitation rates in the watersheds which transport the on land pollutants to the streams through overland and groundwater flows. Waste that was deposited to the land or stored was subjected to a die-off rate. The longer fecal coliform stayed on the ground the greater the die-off was. Materials that were washed off the surface shortly after deposition were subjected to less die-off.

As stated above the model for Beaver Creek was without a full hydrologic calibration since there was limited observed flow data from the stream. The hydrology and water quality models were developed for the 1999 through 2003 time period. The water quality model was calibrated to the observed water quality data collected during this time period.

2) The TMDL includes a total allowable load as well as individual waste load allocations and load allocations.

Total Allowable Loads

Virginia indicates that the total allowable loading is the sum of the loads allocated to land based precipitation driven nonpoint source areas (forest and agricultural land segments) and point sources. Activities that increase the levels of bacteria to the land surface or their availability to

runoff are considered flux sources. The actual value for total loading can be found in Table 1 of

this document. The total allowable load is calculated on an annual basis.

Waste Load Allocations

EPA regulations require that an approvable TMDL include individual WLAs for each point source. According to 40 CFR § 122.44(d)(1)(vii)(B), "Effluent limits developed to protect a narrative water quality criterion, a numeric water quality criterion, or both, are consistent with assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA pursuant to 40 CFR § 130.7." Furthermore, EPA has authority to object to the issuance of any National Pollutant Discharge Elimination System (NPDES) permit that is inconsistent with the WLAs established for that point source.

Virginia has stated that there are seven small regulated point sources discharging within the Beaver Creek Watershed. A WLA has been provided for each of these facilities based on their flow, 1,000 gallons per day, and the permissible concentration of e-coli in their effluent, 126 cfu/100 ml. Table 2 documents the WLA for each of these point sources.

Table 2 – WLA for Bacteria for Beaver Creek

Permit Number	Facility	Flow (gpd)	Fecal Coliform (cfu/yr)	E-Coli (cfu/yr)
VAG401004	Single Family Unit	1,000	2.76E+09	1.74E+09
VAG401143	Single Family Unit	1,000	2.76E+09	1.74E+09
VAG401144	Single Family Unit	1,000	2.76E+09	1.74E+09
VAG401478	Single Family Unit	1,000	2.76E+09	1.74E+09
VAG401599	Single Family Unit	1,000	2.76E+09	1.74E+09
VAG401679	Single Family Unit	1,000	2.76E+09	1.74E+09
VAG408022	Single Family Unit	1,000	2.76E+09	1.74E+09

Load Allocations

According to Federal regulations at 40 CFR § 130.2(g), LAs are best estimates of the loading, which may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting loading. Wherever possible, natural and nonpoint source loads should be distinguished.

In order to accurately simulate landscape processes and nonpoint source loadings, VADEQ used the HSPF model to represent the impaired watersheds. The HSPF model is a comprehensive modeling system for the simulation of watershed hydrology, point and nonpoint source loadings, and receiving water quality. HSPF uses precipitation data for continuous and storm event simulation to determine total loading to the impaired segments from the various land uses within the watershed. Table 3 lists the LAs for Beaver Creek. The reductions needed to insure that the instantaneous criteria are attained at all times are extremely stringent. If the 10 percent violation rate required for a water to be placed on the Section 303(d) list was used as an

endpoint, the reductions would not be as stringent. Reductions from livestock direct deposit sources were not required in Lower Beaver Creek because many of these animals have already been excluded from the stream via fencing and those that still have access do not contribute a significant load.

Table 3 - LA for Bacteria (fecal coliform) for Beaver Creek

Source Category	Existing Load (cfu/yr)	Proposed Load (cfu/yr)	Percent Reduction
Livestock Direct Deposit	3.30E+13	1.10E+13	66
Wildlife Direct Deposit	1.50E+13	1.00E+13	33
Straight Pipes	2.2E+13	0.00	100
Residential	2.02E+14	1.21E+14	40
Cropland	1.56E+14	9.30E+13	40
Pasture	1.65E+16	0	100
Forest	6.70E+13	6.70E+13	0

3) The TMDL considers the impacts of background pollution.

The TMDL considers the impact of background pollutants by considering the bacteria load from background sources like wildlife.

4) The TMDL considers critical environmental conditions.

According to EPA's regulation 40 CFR § 130.7 (c)(1), TMDLs are required to take into account critical conditions for stream flow, loading, and water quality parameters. The intent of this requirement is to ensure that the water quality of Beaver Creek is protected during times when it is most vulnerable.

Critical conditions are important because they describe the factors that combine to cause a violation of water quality standards and will help in identifying the actions that may have to be undertaken to meet water quality standards[3]. Critical conditions are a combination of environmental factors (e.g., flow, temperature, etc.), which have an acceptably low frequency of occurrence. In specifying critical conditions in the waterbody, an attempt is made to use a reasonable "worst-case" scenario condition. For example, stream analysis often uses a low-flow

[3]EPA memorandum regarding EPA Actions to Support High Quality TMDLs from Robert H. Wayland III, Director, Office of Wetlands, Oceans, and Watersheds to the Regional Management Division Directors, August 9, 1999.

(7Q10) design condition because the ability of the waterbody to assimilate pollutants without exhibiting adverse impacts is at a minimum.

The HSPF model was run over a multi-year period to insure that it accounted for a wide range of climatic conditions. The allocations developed in the TMDL will therefore insure that the criterion is attained over a wide range of environmental conditions including wet and dry weather conditions.

5) The TMDL considers seasonal environmental variations.

Seasonal variations involve changes in stream flow and loadings as a result of hydrologic and climatological patterns. In the continental United States, seasonally high flows normally occur in early spring from snow melt and spring rain, while seasonally low flows typically occur during the warmer summer and early fall drought periods.

Bacteria loadings also change during the year based on crop cycles, waste application rates, and cattle access patterns. Consistent with our discussion regarding critical conditions, the HSPF model and TMDL analysis effectively considered seasonal environmental variations through the use of observed weather data over an extended period of time and by modifying waste application rates, crop cycles, and livestock practices.

6) The TMDL includes a margin of safety.

This requirement is intended to add a level of safety to the modeling process to account for any uncertainty. The MOS may be implicit, built into the modeling process by using conservative modeling assumptions, or explicit, taken as a percentage of the WLA, LA, or TMDL. Virginia included an implicit MOS in the TMDL through the use of conservative modeling assumptions in the determination of bacteria loadings and production.

7) There is a reasonable assurance that the TMDL can be met.

EPA requires that there be a reasonable assurance that the TMDLs can be implemented. WLAs will be implemented through the NPDES permit process. According to 40 CFR 122.44(d)(1)(vii)(B), the effluent limitations for an NPDES permit must be consistent with the assumptions and requirements of any available WLA for the discharge prepared by the state and approved by EPA. Furthermore, EPA has authority to object to issuance of an NPDES permit that is inconsistent with WLAs established for that point source.

Nonpoint source controls to achieve LAs can be implemented through a number of existing programs such as Section 319 of the CWA, commonly referred to as the Nonpoint Source Program.

8) The TMDL has been subject to public participation.

Two public meetings were held to discuss and disseminate the Beaver Creek TMDL to the public. The meetings were held at the Ottobine Elementary School in Dayton on September 22, 2004 and July 12, 2005. The meetings and TMDLs were noticed in the Virginia Register for a 30-day comment period. In addition to the public meetings, the TMDL developers met with a local steering committee.